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SPECIFICATIONS

TO BE FOLLOWED BY CONTRACTORS IN MAKING DESIGNS

FOR

MACHINERY

FOR

Torpedo Boats Nos. 3, 4, and 5,

TO MAKE A SPEED OF TWENTY-FOUR AND ONE-HALF KNOTS PER HOUR
AT A DISPLACEMENT OF 138 TONS.

BUREAU OF STEAM ENGINEERING,
NAVY DEPARTMENT,
WASHINGTON, D. C.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1894.



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INDEX.

A.		Page.	
Air cocks, boiler	26	Boiler manholes and hand- holes	21
Air-pressure gauges	28	Boiler material	20
Air pumps	14	Boiler protectors, zinc	26
Apparatus, distilling	29	Boiler pumping-out pipes	25
Ash hoists	28	Boiler saddles	22
Ash sprinklers	28	Boiler stop valves	22
Attachment of valves to hull	35	Boiler tubes	20
Auxiliary-engine stop valves	34	Boiler water gauges	25
Auxiliary exhaust pipes	31	Boilers and machinery, tests of	43
Auxiliary feed pipes	32	Bolts and nuts	12
Auxiliary feed pumps	27	Bottom blow valves	24
Auxiliary feed pumps, deck connection	32	Boxes, journal	11
Auxiliary steam pipes	30	Boxes, stuffing	12
B.		Bracket bearings, stern	13
Bars and bearers, grate	21	Brasses, crank-shaft	7
Bearers, grate bars and	21	Brasses, crank-pin	7
Bearings, stern-bracket	13	Brasses, crosshead	7
Bearings, stern-tube	13	Bulkheads, shafts through	38
Bearings, thrust	12	Bulkheads, pipes through wa- ter-tight	32
Bedplates and pillow blocks	7	C.	
Bidders, instructions to	1	Changes in plans and specifi- cations	47
Bilge strainers	35	Check valves, feed	23
Bilge-suction pipes and steam ejectors	16	Chests, valve	4
Bleeder pipes	31	Circulating-pump connec- tions	15
Blowpipes	25	Circulating pumps	14
Blow valves, bottom	24	Circulating-pump engine	15
Blow valves, surface	25	Clearances. (See cylinders)	3
Blower engines	28	Clocks	20
Blowers, fire-room	28	Clothing and lagging	37
Boilers	20	Cocks and valves	35
Boilers, steam gauges for	25	Cocks, boiler air	26
Boiler air cocks	26	Cocks, boiler drain	26
Boiler attachments	22	Cocks, cylinder drain	6
Boiler casings and uptakes	21	Cocks, gauge	26
Boiler drain cocks	26		

III

	Page.
Condensers.....	14
Connecting rods.....	6
Connections, circulating-pump.....	15
Copper pipes, thickness of.....	33
Counters, revolution.....	18
Crank-pin brasses.....	7
Crank-shaft brasses.....	7
Crank shafts.....	10
Crosshead brasses.....	7
Crossheads.....	6
Crosshead guides.....	8
Cylinder clearances. (<i>See</i> cylinders).....	3
Cylinder drain cocks.....	6
Cylinder relief valves.....	5
Cylinders.....	3
Cylinders, pump.....	16

D.

Decks and water-tight bulk-heads, pipes through.....	32
Deck connections from auxiliary feed pumps.....	32
Desk, engine-room.....	20
Distilling apparatus.....	29
Doors, furnace.....	21
Drain cocks, boiler.....	26
Drain cocks, cylinder.....	6
Drainpipes and traps.....	33
Drawings of completed machinery.....	47
Drawings, working.....	46
Drips, oil.....	11
Dry pipes.....	23
Duplicate pieces.....	40

E.

Ejectors, steam, and bilge-suction pipes.....	16
Engineer's office, superintending.....	46
Engine, circulating-pump.....	15
Engine frames.....	7
Engine indicators.....	19
Engine-room desk.....	20
Engine-room telegraphs.....	18
Engine-room water service.....	17

	Page.
Engine stop valves, auxiliary.....	34
Engine throttle valves.....	5
Engine, securing, in vessel.....	17
Engines, blower.....	28
Escape pipes.....	32
Evaporators.....	29
Exhaust pipes.....	9
Exhaust pipes, auxiliary.....	31

F.

Feed check valves.....	23
Feed pipes, main.....	32
Feed pipes, auxiliary.....	32
Feed pumps, main.....	27
Feed pumps, auxiliary.....	27
Feed-pump pressure gauges.....	27
Feed tanks.....	15
Feed-tank suction pipes.....	15
Fire-room blowers.....	28
Fitting and material of pipes.....	33
Floors.....	38
Frames, engine.....	7
Furnace doors.....	21

G.

Gauge cocks.....	26
Gauges, air-pressure.....	28
Gauges, boiler water.....	25
Gauges, feed-pump pressure.....	27
Gauges for boilers, steam.....	25
Gauges, steam and vacuum.....	17
Gear for working valves from deck.....	39
Gear, lifting.....	39
Gear, reversing.....	9
Gear, turning.....	17
Gear, valve.....	8
General requirements.....	2
Grate bars and bearers.....	21
Guides, crosshead.....	8

H.

Hand rails.....	39
Hand-holes and manholes, boiler.....	21
Hose and attachments.....	38
Hoists, ash.....	28

IV

I.	Page.
Indicators, engine.....	19
Inspection.....	48
Instruction to bidders.....	1
Instruments, labels on gear and	36
Intermediate and low pres- sure steam pipes	31

J.	
Joints, riveted	20
Journals and journal boxes..	11

L.	
Labels on gear and instru- ments.....	36
Ladders.....	39
Lagging and clothing	37
Lifting gear.....	39
Low and intermediate pres- sure steam pipes	31
Lubrication.....	10

M.	
Machinery and boilers, tests of	43
Machinery, drawings of, com- pleted	47
Manholes and hand-holes, boiler.....	21
Mandrels for white-metal bearings	11
Main feed pipes.....	32
Main feed pumps.....	27
Main steam pipes.....	30
Main steam valves.....	5
Materials and workmanship.	42
Material, boiler	20
Material, tests of.....	43
Material and fitting of pipes.	33

N.	
Nuts and bolts	12

O.	Page.
Office, superintending engi- neer's	46
Oil drips	11
Oil tanks	39
Omissions	48

P.	
Painting	45
Pipes, auxiliary feed	32
Pipes, auxiliary steam.....	30
Pipes, auxiliary exhaust.....	31
Pipes, bilge suction	16
Pipes, bleeder.....	31
Pipes, blow	25
Pipes, boiler pumping-out ...	25
Pipes, drain and traps	33
Pipes, dry.....	23
Pipes, escape.....	32
Pipes, exhaust	9
Pipes, exhaust, auxiliary	31
Pipes, feed-tank suction.....	15
Pipes, intermediate and low pressure steam	31
Pipes, material and fitting of	33
Pipes, main feed.....	32
Pipes, main steam.....	30
Pipes, sea suction	15
Pipe, smoke.....	21
Pipes, thickness of copper ...	33
Pipes through water-tight bulkheads and decks	32
Pistons	5
Piston-rod stuffing boxes	6
Piston rods.....	5
Plans and specifications, changes in	47
Platforms, working.....	9
Preliminary tests and trials..	45
Propellers, screw.....	13
Propeller shafts	10
Pump cylinders	16
Pump relief valves	17
Pumps, air	14
Pumps, auxiliary feed	27
Pumps, circulating	14
Pumps, main feed	27

R.		Page.		Page.
Radiators		37	Suction pipes, bilge and steam ejectors	16
Record of weights		46	Suction pipes, feed-tank	15
Rails, hand		39	Suction pipes, sea	15
Relief valves, cylinder		5	Superintending engineer's office	46
Relief valves, pump		17	Surface blow valves	25
Requirements, general		2		
Reversing gear		9	T.	
Revolution counters		18	Tanks, feed	15
Riveted joints		20	Tanks, oil	39
Rods, connecting		6	Telegraphs, engine-room	18
Rods, piston		5	Tests and trials, preliminary	45
			Tests of boilers and machinery	43
			Tests of material	43
S.			Thermometers	18
Safety valves		23	Thickness of copper pipes	33
Saddles, boiler		22	Throttle valves, engine	5
Screw propellers		13	Thrust bearings	12
Sea-suction pipes		15	Tools	40
Sea valves		34	Trials, preliminary tests and	45
Securing engines in vessel		17	Traps and drainpipes	33
Shafts		9	Tubes, boiler	20
Shafts, crank		10	Tube cleaners, steam	28
Shafts, propeller and stern tube		10	Turning gear	17
Shafts, through bulkheads		38		
Smoke pipes		21	U.	
Specifications and plans, changes in		47	Uptakes, boiler casings and	21
Sprinklers, ash		28		
Steam and vacuum gauges		17	V.	
Steam ejectors and bilge suc- tion pipes		16	Vacuum gauges, steam and	17
Steam gauges for boilers		25	Valve chests	4
Steam pipes, auxiliary		30	Valve gear	8
Steam pipes, main		30	Valve stems, main valves and	5
Steam tube cleaners		28	Valve-stem stuffing boxes	6
Stems, valve		5	Valves, attachment of, to hull	35
Stern-bracket bearings		13	Valves, auxiliary-engine stop	34
Stern-tube bearings		13	Valves, boiler stop	22
Stern-tube stuffing boxes		13	Valves, bottom blow	24
Stop valves, boiler		22	Valves, cocks and	35
Stop valves, auxiliary engine		34	Valves, cylinder relief	5
Strainers, bilge		35	Valves, engine throttle	5
Stuffing boxes		12	Valves, feed check	23
Stuffing boxes, piston-rod		6	Valves, gear for working from deck	39
Stuffing boxes, stern-tube		13		
Stuffing boxes, valve-stem		6		

VI

	Page.		Page.
Valves, main steam and valve stems	5	Water-tight bulkheads, pipes through	32
Valves, pump relief	17	Weights, record of	46
Valves, safety	23	Whistle	38
Valves, sea	34	White-metal bearings, man- drels for	11
Valves, stop, auxiliary-engine	34	Working drawings	46
Valves, surface blow	25	Working platforms	9
		Workmanship and materials ..	40
W.		Z.	
Water gauges, boiler	25	Zinc boiler protectors	26
Water service, engine-room ..	17		

SPECIFICATIONS
FOR
VERTICAL TWIN-SCREW PROPELLING ENGINES,
WITH
BOILERS AND AUXILIARY MACHINERY,
FOR
TORPEDO BOATS Nos. 3, 4, and 5,
THE BOILERS AND MACHINERY TO BE BUILT ACCORDING TO
DESIGNS SUBMITTED BY THE CONTRACTORS.

1. INSTRUCTIONS TO BIDDERS.

The following specifications have been prepared for the purpose of showing to contractors who intend to submit bids on designs furnished by themselves what degree of workmanship, what accessories, and what auxiliary machinery is necessary, thus putting all bidders on an equal footing by giving them a tangible base for their estimates.

As the contractors will be responsible for the good performance of the machinery, the Department is desirous of leaving them as free as possible in their choice of type of boilers and engines, and their proportions and general design. If, however, any bidder should consider any of the requirements unreasonable, or that they hamper him in any way in making an efficient design, he will make a statement to that effect in connection with his bid, giving his reasons for objection in full. It is to be understood, however, that the bids shall include everything herein specified in case the Department shall see fit to overrule any objections thus made.

The following drawings will be required to accompany bids:

A plan of the general arrangement of boilers and machinery in the vessel in plan, elevation, and cross section, to a scale of $\frac{1}{2}$ inch to the foot. This plan will have noted upon it the weight and position of center of gravity of the boilers, smoke pipes, and all machinery and gear in the boiler compartments, including water in boilers to steaming level, and in pipes, pumps, etc.; weight and position of center of gravity of engines and shafting, as far aft as the after engine-room bulkhead, including all fittings, auxiliary machinery, spare gear, stores, water in condenser, pumps, pipes, etc.; weight and position of center of gravity of screw propellers, shafting, bearings, etc., and spare gear and stores as far forward as the after engine-room bulkhead, including water in stern pipes, etc.; also the total weight and position of center of gravity of boilers, engines, fittings, spare parts, tools, stores, water in boilers, and machinery, and everything pertaining to the engineer's department of the vessel when fully equipped for service.

Detail of the boilers to a scale of not less than $1\frac{1}{2}$ inches to the foot.

Elevations of one set of propelling engines to a scale of not less than $1\frac{1}{2}$ inches to the foot, with sections through cylinders and valve chests.

A drawing of one condenser to a scale of not less than 3 inches to the foot, in elevation and section.

A drawing of one set of air-pumps to the same scale, in elevation and section.

A section through stern tubes and stern-bracket bearings, showing shafts and screw propellers, to a scale of not less than 3 inches to the foot.

These plans must be accompanied by specifications, which must describe all parts of the machinery as fully as is done in the specifications of the Department's design of machinery for these vessels.

2. GENERAL REQUIREMENTS.

There will be two sets of propelling engines turning twin screws. The engines will be placed in separate



water-tight compartments, as indicated on the plans of the hull. The engines will be of the triple or quadruple expansion type, at the option of the contractor.

The collective indicated horsepower of the propelling engines will be at least 2,000 under forced draft.

The condensers will be made entirely of composition and sheet brass, or of composition alone. The air pumps will be worked from the main engines or shafts. The circulating pumps will be of the centrifugal type, one for each condenser, worked independently. The propellers will be right and left, of manganese bronze or approved equivalent metal.

The boilers will be placed in two water-tight compartments, as shown on the Department's plans of the hull, with the uptakes so arranged as to lead into the smoke pipes in the position shown. Should the contractor find it desirable to change the coal-bunker bulkheads to suit his arrangement of boilers he will submit a plan of such changes with his proposal.

The forced draft will be according to such system as may be chosen by the contractor and approved by the Navy Department. The location and number of feed pumps, depending on the arrangement of boilers, must be approved by the Navy Department. The main and auxiliary feed systems will be complete in themselves.

There will be an evaporating and distilling plant, auxiliary pumps and such other auxiliary or supplementary machinery, tools, instruments, or apparatus as are described in the following detailed specifications.

The space occupied by machinery will not be in excess of that occupied by department design.

The engines and auxiliary machinery must be so designed that no oil will be necessary in the cylinders or valve chests.

3. CYLINDERS.

The cylinders of the main engines will be made of the best quality of cast iron, with working linings for all valve chests.

The steam and exhaust ports and passages must be smoothly cored and thoroughly cleaned out before the valve-chest linings or facings are put in.

The cylinder and valve-chest covers will be fitted with conveniences for breaking joints and for easy handling.

Care will be taken that the clearances are made no larger than absolutely necessary. After the engines are set up in place and connected, the volume of the clearance at each end of each cylinder will be carefully measured by filling the space with water or oil, and the result plainly stamped on some conspicuous part of the cylinder casing. Marks will also be made on the crosshead guides showing the positions of the pistons when the clearances were measured.

4. VALVE CHESTS.

There will be a working lining at each end of each valve chest for each piston valve. They will be of close-grained cast iron as hard as can be properly worked, accurately turned and faced to fit casings, and secured in an approved manner. They will be so fitted that it will be impossible for packing rings to override the seats when valves are disconnected.

The edges of all ports must be finished, and before the working linings or facings are put in place all steam and exhaust passages will be thoroughly cleaned out and care taken that the passages are nowhere contracted to less than the port area. The arrangement of machinery must be such that the working linings or facings can be taken out in case of necessity of renewal.

A pipe and valve of approved size will be fitted to admit steam direct from the main steam pipe to each intermediate and low pressure steam chest.

Each valve chest, except the high-pressure, will have an adjustable-spring safety valve of approved pattern. All valve chests will also be fitted with suitable composition drain-cocks or valves that may be operated from the working platform, and discharge through pipes into the condenser or feed tanks, as may be directed.

5. MAIN STEAM VALVES AND VALVE STEMS.

The main steam valves will be piston valves of approved type.

The valve stems will be of forged steel oil tempered and accurately and smoothly ground where they pass through the stuffing boxes.

6. PISTONS.

The pistons will be of cast or forged steel finished all over and dished. They will be fitted with approved packing.

7. PISTON RODS.

The piston rods will be hollow and made of forged steel oil tempered and accurately and smoothly ground where they pass through the stuffing boxes.

The piston rod will be kept from turning in the piston by stop pins or keys.

8. ENGINE THROTTLE VALVES.

There will be on each engine an approved throttle valve, fitted for working by hand, with levers at the working platform, and an index to show the position of the valve. The valve, stem, and casing will be of composition.

9. CYLINDER RELIEF VALVES.

There will be an adjustable-spring relief valve on each end of each main cylinder, connected with pipes having easily broken joints and leading to the bilge. The valves and their casings will be of composition. These valves will have nickel seats or their equivalent, and the valve fittings will be so constructed that the valves can be easily overhauled without slacking the springs and so that steam will not come into contact with the springs. The springs will have approved means of adjustment, and will be long enough to allow the valves to open to their full extent without unduly increasing the load.

The valves will be guided by loosely fitting wings. The springs will bear on shoulders on spindles which fit loosely in sockets recessed in the backs of the valves.

These spindles will be so fitted that the valves can be moved by the application of a lever. The valves will be fitted with casings, which will prevent danger of persons being scalded by hot water from the cylinders. Suitable fulcrums will be on casings for the application of levers for working the valves; one lever to be furnished for each engine room. All springs must pass a satisfactory test.

The spring casing of each valve will be fitted with a suitable lock; all locks to have similar keys.

10. CYLINDER DRAIN COCKS.

Each main-engine cylinder will be fitted with an asbestos-packed drain cock, placed so as to drain the cylinder throughly. The cocks must be perfectly tight without undue friction. The drain cocks of each cylinder of each engine will be worked by a separate lever. All the drain cocks of the high and intermediate pressure cylinders will discharge into a pipe leading to the feed tank through nonreturn valves; of the low-pressure cylinders into the fresh-water side of the condensers. Small drain cocks will be fitted to the lowest parts of drainpipes.

11. PISTON-ROD AND VALVE-STEM STUFFING BOXES.

They will be made of composition, fitted with an approved metallic packing, and provided with efficient means of lubrication.

The packing of each stuffing box will be made in at least two independent sections, so that in case of injury to one section the other will make a tight joint alone; this packing to be in all respects equal to the best in the market, and subject to the approval of the Bureau of Steam Engineering.

12. CROSSHEADS.

They will be made of forged steel of approved design.

13. CONNECTING RODS.

The connecting rods will be hollow and with their caps and bolts will be of forged steel, finished all over and

oil tempered. The heads of the bolts will be fitted with stop pins and the ends provided with split pins of ample size outside the nuts.

Composition distance pieces will be fitted between the connecting rods and caps; they will be so fitted as to be removable without taking out the cap bolts, and will be channeled so as to be easily reduced when taking up lost motion.

14. CRANK-PIN BRASSES.

They will be accurately fitted to the connecting-rod ends and secured by the cap bolts. They will be fitted with approved white metal in strips, accurately fitted to the crank pins, and properly grooved for distribution of oil. They will be faced with sufficient clearance between crank webs to prevent nipping when heated.

15. CROSSHEAD BRASSES.

They will be accurately fitted to the crosshead pin and will be properly grooved for the distribution of oil.

16. ENGINE FRAMES.

The cylinders will be supported by wrought-steel columns, stiffened by wrought-steel tie-rods in an approved manner so as to minimize vibrations of the engine.

17. BEDPLATES AND PILLOW BLOCKS.

They will be of wrought or cast steel of approved design, and will be secured to the supporting columns of cylinders in an approved manner.

18. CRANK-SHAFT BRASSES.

They will be fitted with means for vertical adjustment and will be lined with white metal fitted in dove-tailed recesses and hammered in place. They will be provided with ample oil channels and faced on the ends, and will be accurately bored to fit the journals of the shaft, and the shaft will be carefully bedded. The lower brasses must be removable while the shaft is in place.

The caps for all crank-shaft bearings will be secured by stud bolts of forged steel and the parts of bolts beyond the nuts will be fitted with split pins.

The caps and brasses will be tapped and fitted with eyebolts for handling.

After the engines are secured in the vessel the brasses and caps will be bored out in place to perfect alignment, if required. They will also be tried on their shafts and any defects made good by scraping to a proper bearing.

The brasses and caps will be so fitted that the only bearing of the journals will be on the surface of the white metal.

19. CROSSHEAD GUIDES.

They will be of approved design with sufficient surface to insure against heating either in ahead or backing motion. They will be smoothly and accurately finished and will be fitted to proper alignment. They will be provided with proper oil channels and brass oil boxes for supplying oil.

20. VALVE GEAR.

The type of valve gear will be at the option of the contractor, but must be of an approved design.

If an eccentric gear is used, the eccentrics will be of cast steel.

The eccentric straps will be of composition or cast steel, lined with white metal, finished all over, and held together by forged-steel bolts with finished heads, lock nuts, and split pins, and will be fitted with channeled brass distance pieces. Each strap will be properly channeled for oil.

The eccentric rods will be of forged steel, finished all over.

Valve-motion rock shafts will be made of steel, finished all over. The arms may be made of cast steel if desired, securely keyed to the shafts and finished all over.

Rock-shaft bearings will be fitted with adjustable brasses.

All links used in the valve gear will have adjustable brasses except where otherwise allowed.

If the Stephenson link motion is used, the links will be of forged steel, finished all over.

The link blocks will be of forged steel, finished all over, and will have their pins forged on. The jaws will be fitted with adjustable composition gibs.

21. REVERSING GEAR.

The reversing gear will be of approved design. It may be worked by steam, but must be also capable of working by hand and must prove to be capable of reversing the engine, in either direction, in four seconds when running at full speed.

Whatever kind of reversing gear may be used, it will be so fitted that it will be impossible to put the valve gear in a dangerous position, or cause any break-down by a want of caution in handling the reversing gear.

The reversing shafts and arms will be made of forged steel, finished all over, and carried in adjustable bearings.

22. EXHAUST PIPES.

They will be made of copper, with expansion joints if considered necessary.

23. WORKING PLATFORMS.

A working platform will be conveniently arranged in each engine room with the counter, revolution indicators, clock, gauges, and telegraph dials in full view while working the engines, and with telegraph levers and speaking-tube mouthpieces within easy reach.

Gear will be fitted at each platform, so as to be within easy reach of one person, for working the reversing gear, throttle, starting valves, cylinder drain cocks, and bleeder valve.

All levers will have spring latches of "locomotive pattern." The latches on reversing levers will be of the best type and subject to the approval of the Bureau of Steam Engineering.

24. SHAFTS.

All of the crank, line, thrust, stern-tube, and propeller shafts, will be of steel, each length forged solid in one piece. All shafts will be finished all over. All couplings

will be forged on the shafts, except those on stern-tube shafts, inboard end of propeller shafts, and outboard end of line shafts, which must be so arranged that the propeller and stern-tube shafts may be taken out without disturbing the stern tubes and brackets.

A worm wheel for the turning gear will be fitted to each shaft. Coupling bolts will be of steel, with nuts secured in an approved manner.

25. CRANK SHAFTS.

There will be holes bored axially through each crank shaft and through each crank pin. The crank pins must be accurately parallel to the main journals. All journals and crank pins are to be smoothly and accurately turned and ground, and when finished will be tested and their accuracy proved.

26. PROPELLER AND STERN-TUBE SHAFTS.

The propeller shafts will each be in one section. They will be cased with composition, shrunk and pinned on, so as to be water-tight. The casings must be accurately and smoothly turned to form journals. The coupling at the forward end will be inclosed in a brass casing, which will be secured in a satisfactory manner.

There will be at the forward end a steel sleeve, to form a fair water line from the end of the stern tube to the shaft.

The shaft, couplings, and casings will be well coated with the same composition as the hull.

The stern-tube shafts will be fitted with casings in a similar manner to those on the propeller shafts.

27. LUBRICATION.

All working parts of the machinery will be fitted with approved and efficient lubricators, each with a sufficient oil capacity for four hours' running. Each lubricator to be fitted with a tube leading to the wipers on the moving parts, or tubes in the bearings and guides. Each tube from the lubricators will be fitted with a valve adjustment, and a sight feed with a well protected glass tube.

Unions will be fitted where necessary, so that the oil pipes may be quickly taken down and cleaned, and each pipe where connected to a bearing or oil cup will have a union joint.

As far as possible all the oil for the moving parts of each cylinder, except main bearings, will be supplied from one oil box on the cylinder with separate valve, sight feed, and pipe for each part to be oiled. All the oiling of each auxiliary engine will be done by one oil box where practicable. All fixed oil cups will have hinged covers, with stops to prevent being opened too far. Moving oil cups, where necessary, will have removable covers. The supply of oil to various parts is to be easily regulated. All oil cups and their fittings, except such as are cast on bearings, will be of finished cast brass, or of sheet brass or copper, as may be directed, with all seams brazed.

28. OIL DRIPS.

All fixed bearings will have drip cups cast on where possible, otherwise they will be of sheet brass, properly applied. All moving parts will have drip cups or pans placed where directed, and substantially made of sheet brass or copper, with brazed seams. All drip cups will have drain pipes and cocks of at least $\frac{1}{2}$ inch diameter, which can be used while the engines are in operation.

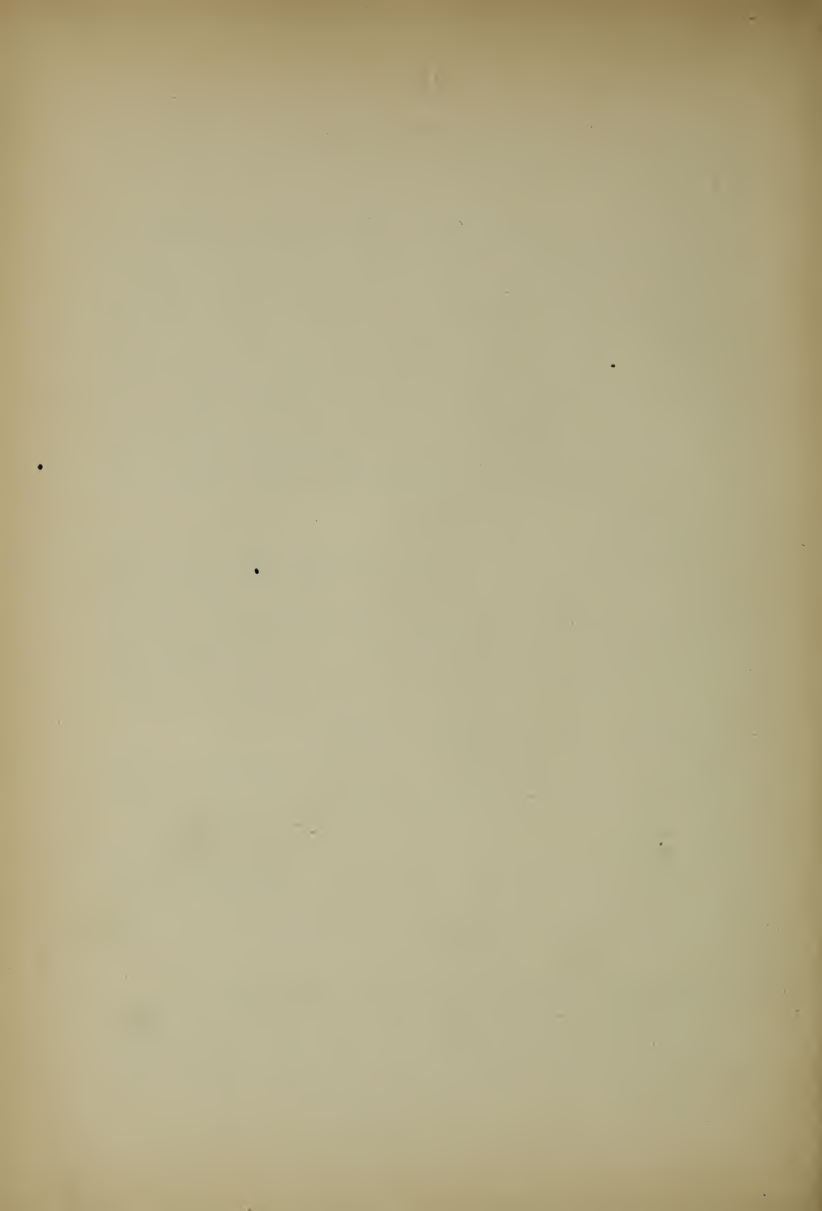
29. JOURNALS AND JOURNAL BOXES.

All pins which are rotary or vibratory journals will be of forged steel, hardened and ground. All pins on which the motion is vibratory will be flattened on the sides.

All journals or moving parts of iron or steel will run, unless otherwise specified, in composition boxes. These boxes will be lined with approved antifriction metal where directed. All adjustable bearings will be provided with channel brass-chipping pieces securely held in place and easily removable.

30. MANDRELS FOR WHITE-METAL BEARINGS.

Hollow cast-iron mandrels will be furnished for forming the white-metal linings of crank-pin, crank-shaft, line-shaft, and thrust bearings. All these will be smoothly



and accurately turned to size, and packed so as to be perfectly protected.

31. STUFFING BOXES.

All iron boxes will be bushed with composition. All glands will be of composition and fitted with approved means of adjustment while the engines are in operation, and those not fitted with pinion nuts and spur rings will have lock nuts and split pins. Metallic packing, subject to the approval of the Bureau of Steam Engineering, will be fitted in stuffing boxes of all piston rods and valve stems of main and auxiliary engines. For piston rods and valve stems the packing will be in at least two independent sections.

32. BOLTS AND NUTS.

All bolts and nuts less than 2 inches, except in special cases, will conform to the U. S. Navy standard. All finished bolts, where directed, will be kept from turning by dowels or other suitable devices. This specification is intended to apply to all pumps and auxiliary engines, as well as to parts of the main engines and boilers.

The nuts of all bolts on moving parts and on pillow blocks, and elsewhere as required, will be locked, and the bolts will be fitted with split pins.

33. THRUST BEARINGS.

They will be lined with approved white metal. Separate bearings will be provided to take the weight of the shaft so that no part of it will come on the thrust-bearing proper. Stuffing boxes will be provided at the ends of the bearings so that the shaft may run in oil. Means will be provided for circulation of water to cool the oil. The bearings must be adjustable, both fore and aft and athwartship. Oil holes will run to each collar and each recess, so as to thoroughly lubricate the bearing at both high and low speed. The caps will be fitted with gear for easy handling. A drain cock will be provided at each end of each bearing.



34. STERN-TUBE BEARINGS.

They will be made of white metal run in around a mandrel of the proper size, and will not be bored. There will be a bearing in each end of each stern tube. The white metal will be held from turning by screws passing through the tube and entering the metal.

There will be a zinc protecting ring on the outside of the afterbearing.

35. STERN-TUBE STUFFING BOXES.

To the forward end of each stern tube there will be riveted a composition stuffing box. The follower will be of composition.

The follower bolts will be of rolled manganese or Tobin bronze.

36. STERN-BRACKET BEARINGS.

There will be two strut bearings on each side of the vessel; each bearing will be bored out, and a tube will be fitted, and lined with white metal to form a bearing for the shaft.

A zinc protecting ring will be fitted between the after strut bearing and the propeller.

Each strut bearing will be fitted with a fair water line sleeve, as already specified.

37. SCREW PROPELLERS.

They will be of manganese bronze or approved equivalent metal. The starboard propeller will be right and the port one left handed.

Each boss will be accurately bored to fit the taper on after end of shaft and fitted with two feather keys. Each propeller will be held on the shaft by a nut screwed on and locked in place. The shaft casing will enter about $\frac{1}{2}$ inch into the propeller boss and be fitted water-tight. Each boss will be finished at the after end by a conical composition cap bolted on water-tight; the bosses and caps will be finished all over. The screw propellers will be cast as smooth as possible and polished all over.

Before being placed in position on the shafts, the propellers will be swung on a mandrel or between centers and

accurately balanced by removing the extra metal on the heavier blades.

38. CONDENSERS.

They will be made of composition or sheet brass. There will be a separate screw gland for each end of each tube, with provision to prevent the tube from crawling. Riveted joints, if any are used, will be tinned and sweated before riveting, the tinning extending beyond the seams on the outside of the condenser, so that any leaks can be easily soldered. The tubes must be at least No. 20, B. W. G., in thickness. Deflecting plates will be fitted to prevent the steam impinging directly on the tubes. Man-hole plates will be fitted for getting into the fresh-water side of the condensers.

Drain cocks will be provided with pipes leading to the bilge, and all cocks to have suitable handles for working them.

All bolts will be of naval brass or Tobin bronze.

The condenser must be perfectly tight all over and be so proved after being secured in place.

39. AIR PUMPS.

They will be made, except where otherwise specified, of composition, and will be worked from the main engines or shafts.

Each air pump, together with its condenser, must maintain a vacuum of within four inches of mercury of a perfect vacuum with the propelling engines at full power.

40. CIRCULATING PUMPS.

There will be one centrifugal circulating pump for each condenser. It will discharge all around the periphery and face of the runner, directly into the water chamber of the condenser, which also forms the pump casing.

The suction of the pump will be fitted with a scoop on the outside of the vessel with holes having a combined area equal to twice that of the suction pipe.

The pumps will be subjected to a test hereinafter provided for.

They will be made of composition except as directed.

41. CIRCULATING-PUMP ENGINES.

They will be of approved pattern, each of sufficient power to secure the results above specified. The engine valves must be of either the slide or piston type.

42. CIRCULATING-PUMP CONNECTIONS.

Each circulating pump will be fitted with pipes and valves to draw from the sea, and from the main drain, and will deliver into the condenser.

There will be a nonreturn screw stop valve in the pipe leading from the main drain to the circulating pump.

All valves on circulating pump connections will be made especially light, and the designs will be submitted to the Bureau of Steam Engineering for approval.

43. FEED TANKS.

There will be a feed tank for each engine, placed in the adjoining fire room. Each tank will have a capacity of about 200 gallons. It will be made of No. 14, B. W. G., tinned copper, well stayed, and will be provided with screw manholes for cleaning.

Each tank will have a branch tank adjoining it and placed in the engine room. This engine-room tank will be 1 foot square, with its top 2 feet higher than the fire-room tank. They will be connected at the lowest points. The one in the engine room will have an open top, that in the fire room will have a vapor pipe.

The air-pump discharge and feed-pump suction will be connected with the engine-room tank.

44. FEED-TANK SUCTION PIPES.

The feed tanks will be connected by a pipe from which branches shall be led to the main and to the auxiliary feed pumps. A screw nonreturn valve will be fitted in each of these branches close to the pump.

45. SEA-SUCTION PIPES.

A pipe will lead from the sea-suction valve in each fire room to the auxiliary feed pump in that fire room of the full size of the pump suction. Each of these pipes will be of at least the same bore as the nozzle on the pump

with which it connects. Each sea suction will be controlled by a valve which will not permit sea water to enter any of the bilge-suction pipes or feed-tank suction pipes.

46. BILGE-SUCTION PIPES AND STEAM EJECTORS.

There will be the following suction pipes from the bilge and from the drainage pipe to the various pumps:

A 6-inch copper pipe will connect to each circulating pump, with a nonreturn screw stop valve close to the pump, as before specified. This pipe will connect with the main drainpipe.

A copper pipe of the size of the suction nozzle of each auxiliary feed pump will connect that pump with the main drainpipe. The auxiliary feed pumps will also have suctions leading direct to the bilges if required.

There will be one steam ejector, connected directly with the bilge, in each compartment where directed.

These ejectors will lead through the ship's side above the water line, and will be provided with a straightway valve to prevent water running into the bilge when the boat rolls. They will connect with the auxiliary steam pipes.

Each ejector will have a capacity of 25 tons per hour.

The lower ends of bilge-suction pipes will be of galvanized iron. Care will be taken that all the copper bilge pipes are led sufficiently high to keep them out of the bilge water under ordinary circumstances.

Each bilge-suction pipe must be supplied with an approved basket strainer, or its equivalent.

47. PUMP CYLINDERS.

All pump cylinders, together with their valve boxes and fittings, will be made of composition. Air chambers will be fitted on the delivery sides of pumps or in the pipes, as may be directed.

The water cylinders of all vertical pumps will be so arranged that the pistons are easily accessible and fitted for overhauling without disturbing the framing or piping. All pumps will have packed pistons.

48. PUMP RELIEF VALVES.

All feed and fire pumps will have adjustable spring relief valves of approved design connecting the delivery and suction passages.

49. ENGINE-ROOM WATER SERVICE.

There will be in each engine room for each engine a 1½-inch pipe connected with a sea valve and with a special delivery from the auxiliary feed pump, with branches leading to the different parts of its engine, as follows:

- Two ½-inch pipes to each crank pin;
- Two ½-inch pipes to each crosshead;
- One ½-inch pipe to each crosshead guide;
- One ½-inch pipe to each air-pump eccentric;
- One 1-inch pipe to each thrust bearing;
- One ½-inch pipe to each crank-shaft bearing;
- One ½-inch pipe to each connection and bearing on valve-motion shaft, or to each eccentric;
- One ½-inch pipe to each circulating-pump engine;
- One ½-inch pipe to each blower engine;

All of the above to have detachable sprays or short lengths of hose, as directed, and where directed to have pivoted nozzles.

Each branch will have a separate valve.

All the water-service pipes and fittings above the floors will be of copper No. 20, B. W. G.

50. TURNING GEAR.

There will be approved gear fitted to each engine for turning it by hand.

51. SECURING ENGINES IN VESSEL.

The holding-down bolts will be firmly set up and nuts locked.

When finally secured, all shafting must be accurately in line with the vessel at load draft and ordinary stowage.

52. STEAM AND VACUUM GAUGES.

There will be the following gauges, in polished brass cases, suitably engraved to show to what they are con-

nected; all to be of approved pattern, having seamless double Bourdon tubes:

One or more on each boiler, depending on type of boiler;

One connected to each steam pipe in each engine room;

One connected to each intermediate valve chest;

One connected to each low-pressure receiver of each engine;

One connected to each condenser;

One on each circuit of radiator pipes near the reducing valve.

All of the above will have $4\frac{1}{2}$ -inch dials; those in engine room to be at the working platforms.

The gauges on valve chests will be plainly marked with the limit of pressure permissible.

The gauges on intermediate and low pressure valve chests will indicate both pressure and vacuum.

53. THERMOMETERS.

There will be the following dial thermometers, all to be permanent fixtures, of approved make, and will operate by the difference of expansion of two metals soldered together in a spiral spring:

One on each hot well;

One on each feed tank;

One on each main injection pipe;

One on each main outboard-delivery pipe;

The hot-well and feed thermometers will be so fitted as to waste no feed water.

54. REVOLUTION COUNTERS.

They will be of the continuous rotary type, to register from 1 to 1,000,000, each worked by positive motion; each to be in a polished brass case.

There will be fitted one for each main engine.

55. ENGINE-ROOM TELEGRAPHS.

A mechanical repeating telegraph of approved pattern will be fitted for each engine with its dial at the working platform, and connected to transmitters in conning tower and on deck. They shall be so placed that the

handles point forward for the ahead motion.' The connections are to be made in such manner that the chance of derangement shall be minimized.

There will be an approved signal system between each engine room and its adjoining fire room and between the engine rooms.

56. ENGINE INDICATORS.

An indicator connection will be made to the end of each cylinder of main engines, as near as possible to the bore of the cylinder, and so as to be easily accessible. The indicator cocks will be so fitted on each cylinder of the main engines that the indicators may be connected to both ends of the cylinder; the arrangement to be approved by the Bureau of Steam Engineering. The connecting pipes will be 1 inch bore with easy bends.

The motions of the indicator barrels, which will be $1\frac{1}{2}$ inches in diameter, must be accurately coincident with the motion of the corresponding pistons, and such as to give a motion of not more than 2 inches. The gear must be approved by the Bureau of Steam Engineering, and the distance from the guide pulleys on indicator to the point for attachment of string to gear must not be more than 8 inches.

The following indicators will be furnished for each engine: one for each high-pressure cylinder with two springs of 200 pounds, two of 150 pounds, and two of 100 pounds to the inch; one for each intermediate-pressure cylinder, with two springs of 80 pounds, and two of 60 pounds to the inch; one for each low-pressure cylinder, with two springs of 40 pounds, two of 30 pounds, and two of 20 pounds to the inch.

The indicators will be the best in the market, all of the same manufacture and size, and with interchangeable springs, detent motion, and adjustable tension to the barrel spring, and will be subject to the approval of the Bureau of Steam Engineering. They will be nickel-plated, and will be complete with all attachments. One extra cock attachment will be furnished with each indicator. Each indicator will be in a separate locked case, with engraved plate, each case to be conveniently stowed.

57. ENGINE-ROOM DESK.

A black-walnut hinged shelf will be provided to be used as a desk.

58. CLOCKS.

There will be in each engine room, close to the counter, in a polished brass case, an eight-day clock, with 6-inch dial and a second hand. The pattern and movement to be approved by the Bureau of Steam Engineering.

59. BOILERS.

There will be two boilers of the sectional, coil, or tubulous type. The design must be approved by the Bureau of Steam Engineering. The total grate surface will be at least 95 square feet, and the total heating surface at least 5,120 square feet. The boilers must supply sufficient steam to run all the steam machinery on board at full power. Efficient means must be provided for getting at the interior of such parts of the boiler as require attention for examination, cleaning, or repair. They will be built for a working pressure of at least 250 pounds per square inch. All parts of the boiler must be readily accessible for cleaning and painting.

60. BOILER TUBES.

They will be made of knobbled, hammered, charcoal iron, lap-welded or drawn, or solid drawn copper, the best that can be obtained in the market, and subject to the approval of the Bureau of Steam Engineering.

61. BOILER MATERIAL.

All plates used in the construction of the boilers will be open-hearth steel. The rivets will be of open-hearth or Clapp-Griffiths steel. All material will be tested as elsewhere specified.

62. RIVETED JOINTS.

If there is any riveting, in the boiler adopted, a detail of each seam must be submitted to the Bureau of Steam Engineering. All holes must be drilled with plates in position. When the holes are drilled the plates will be separated for the purpose of removing all burrs.

Where possible, hydraulic riveting will be used.

Seams will be calked on both sides in an approved manner.

In parts where hydraulic riveting can not be used, the rivet holes will be coned and conical rivets used.

63. BOILER MANHOLES AND HAND-HOLES.

There will be manholes and hand-holes wherever necessary for examination, repairs, and preservation of the boilers.

The manhole plates will be of cast or forged steel in dished form of approved pattern. Each plate will have a convenient handle.

All plates, dogs, and nuts will be indelibly marked to show to what holes they belong.

64. FURNACE DOORS.

The furnace doors will be of approved pattern, and they must be protected from the heat of the fire. Drawings showing the arrangement of furnace doors must be submitted to the Bureau of Steam Engineering before work is commenced on them.

65. GRATE BARS AND BEARERS.

The grate bars for all boilers will be of wrought iron of approved pattern. The bearers will be made of wrought iron, supported in an approved manner.

66. BOILER CASINGS AND UPTAKES.

The boiler casings will be made of wrought iron or steel of approved thickness, lined with magnesia or other suitable fireproof nonconducting material.

They will be made in sections and fitted so as to be easily removable, and will have doors where necessary for cleaning.

The part forming the uptake will be bolted to lower plates of smoke pipe with slotted holes to allow for expansion.

67. SMOKE PIPES.

There will be two smoke pipes, their tops being 10 feet above the deck.

They will be built of No. 16, B. W. G., iron or steel. The lower part of the pipes will be shaped to connect with the uptakes. If required, the smoke pipes will be stayed in an approved manner.

Each smoke pipe will be inclosed by a casing, four inches greater in diameter than the smoke pipe. This will also be made of No. 16, B. W. G., iron or steel. The outside of the pipe and the inside of the casing will receive two coats of paint before securing them together.

The seams of the pipes will be lapped, those of the casings butted, with a strap on the inside, leaving the outside flush. The outside of the casings must be flush throughout.

The outside appearance of the two smoke pipes must be the same.

68. BOILER SADDLES.

Each boiler will rest and be secured in saddles, or be otherwise secured in an approved manner.

69. BOILER ATTACHMENTS.

Each boiler will have one or more of the following attachments, as directed, depending on the type of boiler adopted, viz:

Stop valves, dry pipes, main and auxiliary feed-check valves, bottom blows, surface blows, steam gauges, safety valves, glass water gauges of approved automatic closing type, gauge cocks, sentinel valves, drain cocks, and air cocks, and a nozzle with a valve and a thread for attaching hose for filling boiler with water.

All external fittings will be of composition unless otherwise directed. All fittings will be flanged and through-bolted or attached in other approved manner. All cocks, valves, and pipes will have spigots or nipples passing through the boiler plates.

70. BOILER STOP VALVES.

There will be a self-closing stop valve, with horizontal spindle, on each boiler.

The valves will be bolted to the front of each boiler, there being a spigot beyond the flange long enough to afford a good fastening for the dry pipe if one is used.

71. DRY PIPES.

If required by the Bureau of Steam Engineering, there will be in each boiler, as high as possible, and properly supported, a brass or tinned-copper dry pipe, extending nearly the length of the boiler, perforated on its upper side with longitudinal slits of such a number and size that the sum of their areas will equal the area of the steam pipe.

The valve end of the pipes will be expanded so as to fit the spigots of the stop-valve nozzles, and will be secured to them by four pins. The pipe will be closed at the inner end and have a $\frac{1}{2}$ -inch drain hole in its underside near each end.

72. FEED-CHECK VALVES.

There will be main and auxiliary check valves on each boiler. They will be placed at front ends of the boilers, and the number will be determined by the Bureau of Steam Engineering when the type of boiler has been adopted.

The valve cases will be so made that the bottom of the outlet nozzle shall be at least $\frac{1}{2}$ inch above the valve seat. The valves will be assisted in closing by phosphor-bronze spiral springs. These valves will have polished brass bent bar handles in lieu of handwheels.

There will be a stop valve between the check valve and the boiler, but the stop valve and check valve must be in the same casing.

73. SAFETY VALVES.

Each boiler will have spring safety valves of such size and number as may be determined by the Bureau of Steam Engineering, after an examination of the boiler drawings. The safety valves will be placed on the stop-valve casings, or in other approved position. There will be two valves in each casing.

Each valve will have a projecting lip and an adjustable ring for increasing the pressure on the valve when lifted, or an equivalent device for attaining the same result. They will be adjustable for pressure up to the

test pressure—the adjusting mechanism to have an index to show the pressure at which the valve is set, and a lock to prevent tampering with the adjustment. The locks on all safety valves will be alike. The springs will be square in cross section, of first-quality of spring steel, and will be nickel-plated. They will be of such a length as to allow the valves to lift one-eighth of their diameters when the valves are set at 250 pounds pressure. They will have spherical bearings at ends, or be connected to the compression plates in such a manner as to insure a proper distribution of pressure. They will be inclosed in cases so arranged that steam will not come in contact with the springs. The spring cases will be so fitted that the valves can be removed without slacking the springs. The valve stems will fit loosely in valves, to bottom below the level of the seats, and will be so secured that the valves may be turned by a wrench or cross bar on top of stem. The valves will be guided by wings below and in an approved manner above. The valves will be fitted with mechanism for lifting by hand from main deck and fire rooms. The mechanism for each pair of valves will be such that the valves will be lifted in succession. All joints in the lifting gear will be composition bushed. The outlet nozzle will be in the base casting, so that the joint at the escape pipe will not have to be broken when taking the valves out. The casings, valves, and spindles will be made of composition. The valve seats will be solid nickel casting screwed into the top of the composition base. A drainpipe leading to the bilge will be attached to each safety-valve casing below the level of the valve seat.

74. BOTTOM-BLOW VALVES.

There will be 1-inch composition bottom-blow valves on each boiler, bolted near the front. The valves will close with the boiler pressure. If required, an internal pipe will lead from each valve to near the bottom of the boiler. The number of valves is dependent upon the type of boiler adopted.

75. SURFACE-BLOW VALVES.

There will be 1-inch surface-blow valves on each boiler, if directed, bolted on or near the front. The valves will close with the boiler pressure. An internal pipe will lead from each valve to near the water line in the boiler, and will be fitted with a scum pan. The valve casing, valve hand wheel, and valve stem, will be of composition.

76. BLOWPIPES.

A 1-inch pipe will connect with the bottom-blow valves in each compartment and with a sea valve in the same compartment. This pipe will have a nozzle for the connection of a pipe for pumping out the boilers, as well as 1-inch nozzles for attachment of pipes from the surface-blow valves. There will be a straightway valve in the blowpipe as near the sea valve as possible.

All joints will be flange joints.

77. BOILER PUMPING-OUT PIPES.

A 1-inch pipe will connect the bottom blowpipe in each compartment with the auxiliary feed pump in the same compartment, with a screw stop valve above the floor near the pump.

78. STEAM GAUGES FOR BOILERS.

The steam gauges will have seamless tubes and will be of the double Bourdon tube type. They will have 6-inch dials, and will be graduated to 300 pounds. Each gauge will have an independent connection to the boiler and will be fitted with a three-way cock, and a coupling for attachment of a test gauge.

The number of gauges on each boiler will depend upon the type of boiler.

79. BOILER WATER GAUGES.

The glass water gauges will be of approved automatic closing pattern, the number depending upon the type of boiler adopted, and will be determined by the Bureau of Steam Engineering. Each gauge will be placed near the front of the boiler, where it is plainly visible. The shut-off and blow-out cocks are each to have a clear

opening at least $\frac{1}{2}$ inch in diameter, and will be packed cocks, with levers and rods for working from fire room. The glasses will be about 16 inches in exposed length. They will be $\frac{3}{4}$ inch outside diameter. The glasses will be well protected. The blow-out cocks will have drainpipes leading to bilge with union joints, $\frac{1}{2}$ inch inside diameter.

In addition to the glass water gauges there will be mica gauges, the type and number to be approved by the Bureau of Steam Engineering.

80. GAUGE COCKS.

There will be asbestos-packed gauge cocks of approved pattern on each boiler, the number depending upon the type of boiler adopted, and will be determined by the Bureau of Steam Engineering.

They will have rods and levers for working from fire room.

Each cock will be independently attached to the boiler. They will be spaced about 4 inches vertically, the lowest one being placed where directed.

Each set will have a drip pan and a $\frac{3}{4}$ -inch copper or brass drainpipe leading to the bilge.

The castings will be sufficiently strong to avoid being broken under ordinary circumstances.

81. BOILER DRAIN COCKS.

Each boiler will have 1-inch asbestos-packed drain cocks of approved pattern. The number and location will be determined by the Bureau of Steam Engineering when the type of boiler has been fixed.

82. BOILER AIR COCKS.

Each boiler will have $\frac{1}{2}$ -inch air cocks. The number and location will be determined by the Bureau of Steam Engineering when the type of boiler has been fixed.

83. ZINC BOILER PROTECTORS.

Each boiler will have rolled zinc plates as boiler protectors. Each strap for holding zinc plates will be filed bright where in contact with zinc and boiler material.

After being bolted in place the outside of the joints will be made water-tight by an approved cement. The location of zinc plates must be approved by the Bureau of Steam Engineering and there will be $1\frac{1}{2}$ square feet of exposed surface, exclusive of edges, for each 100 square feet of heating surface in the boilers.

By means of baskets, troughs, or other approved methods, the disintegrated zinc will be caught.

84. MAIN FEED PUMPS.

There will be one main feed pump in each engine room. They will be of the vertical type, and must be approved by the Bureau of Steam Engineering.

The exhaust cushion must be adjustable. The water cylinders, water pistons, pumps, and pump rods will be of composition or bronze, and all other working parts will be of wrought iron or steel.

Each main feed pump will draw water from the feed tanks, from the air-pump channel way if required, and from the fresh-water tanks, and will deliver into the main feed pipe and fresh-water tanks, the delivery pipe into tanks being a branch of the feed pipe with a valve in it.

The suction and delivery valves will be made of approved metal and must be made of ample size.

85. AUXILIARY FEED PUMPS.

There will be one in each fire room. They will be duplicates of the main feed pumps.

Each auxiliary feed pump will be arranged to draw from the feed tanks, the boilers, the sea, the main drain-pipe, and the bilge if required, at will, and will discharge into the boilers, into the fire main, the water-service pipes, or overboard through the bottom blow.

86. FEED-PUMP PRESSURE GAUGES.

Each main and auxiliary feed pump will have a spring pressure gauge registering from zero to at least 350 pounds per square inch.

87. ASH HOISTS.

The ashes will be hoisted by hand through the fire-room hatch. There will be a suitable arrangement for hooking block of ash whip over the hatch.

88. FIRE-ROOM BLOWERS.

There will be one blower of approved pattern in each fire room.

These blowers must be capable of supplying to the fires continuously, with ease, sufficient air to maintain the maximum rate of combustion.

The spindle bearings must be accessible while the blowers are in motion, and will be of antifriction metal, fitted in composition boxes, and, together with their lubricating apparatus, must be thoroughly protected from dust.

89. BLOWER ENGINES.

They must be of a pattern approved by the Bureau of Steam Engineering.

The lubrication must be automatic and thorough.

The steam pipe for each blower will connect with the top of the auxiliary steam pipe.

The shafts of blower engine will be so fitted that a portable revolution indicator can be quickly and easily applied without removing any part of the mechanism.

90. AIR-PRESSURE GAUGES.

A gauge of a pattern approved by the Bureau of Steam Engineering will be fitted in each fire room to show the air pressure.

These gauges will indicate pressure in inches of water.

91. ASH SPRINKLERS.

A connection with the sea-suction valve of the auxiliary feed pump will be made in each fire room, and will be fitted with the necessary hose and coupling for wetting down ashes.

92. STEAM TUBE CLEANERS.

A steam tube cleaner of approved design will be fitted in each fire room. Steam will be taken from the auxiliary steam pipe. Sufficient length of steam hose will be provided to easily reach all the tubes.

93. DISTILLING APPARATUS AND EVAPORATORS.

The distilling apparatus, placed where directed, will consist of two evaporators and one distiller. Each evaporator will have a maximum capacity of 500 gallons of water per 24 hours. The distiller will have a capacity of 200 gallons of potable water, at 90° F. per 24 hours.

The evaporators will be made with shells and heads of plate steel. They will be vertical, and will be subject to the approval of the Bureau of Steam Engineering. The evaporators and distillers will be so fitted and their tubes will be of such design that the tubes can be readily removed for scaling or repair, with adequate provision for expansion, and will be secured to the tube sheet in an approved manner. They will be either straight, bent, or coiled, as the Bureau of Steam Engineering may approve. The tubes of the evaporators must be so arranged that after the system is removed from the shell it will be accessible in all its parts for scaling. The evaporators will be felted and lagged, and each will be fitted with a safety valve, steam gauge, glass water gauge, salinometer pot, and blow valve. The shell of the evaporator will be tested to 50 pounds to the square inch and the coils and all parts subject to boiler pressure to 250 pounds per square inch. The distiller will be made with shell of sheet brass, flanges and heads of composition, and coils of copper or brass, thoroughly tinned on both sides. Its coil will be fitted with an inlet and outlet valve.

A filter of approved design will be fitted for the distiller.

There will be provided a pump of approved size for each evaporator and connections will be made so that when the evaporators are connected with the condensers, and working under a vacuum, each pump can be used to pump brine from its evaporators, the latter being fed by atmospheric pressure. When the distiller is in use, the evaporator connected with the distiller will be fed by its pump, and the brine will be blown out by the pressure in the evaporator, the same pump being used as a circulating pump for the distiller.

The evaporators will be connected with the condensers through the auxiliary exhaust pipe.

The distiller will be placed as high as possible so that the distilled water will run from the distiller to the water tanks by gravity.

There must be no internal detachable joints in the coils of either evaporator or the distiller.

94. MAIN STEAM PIPES.

A lap-welded or seamless drawn steel pipe of approved size and thickness will connect the stop valves of the boilers in the forward and after fire rooms. The pipes will be led as may be directed, and have stop valves where shown on drawings. The flanges will be wrought steel of approved thickness, bored, faced, and recessed, with the pipe rolled tightly into the flange and turned over to fill the recess flush with the face of the flange. The flanges will be connected by steel bolts.

Straightway valves will be used where directed.

95. AUXILIARY STEAM PIPES.

There will be an auxiliary steam pipe extending through engine and boiler compartments and to the windlass, ejectors, steering and blower engines, air compressors, torpedo motors, and evaporators. It will connect with the auxiliary stop valves in both boiler compartments, and will be of sufficient size to supply all the auxiliary machinery. If required, valves will be placed at the bulkheads and connection will be made between the main and auxiliary steam pipes as may be designated. Wherever pockets necessarily occur the pipe will be drained and trapped. All branches from the pipe to pumps or engines on a lower level will have the stop valve for such machinery close to the main pipe, so that when the pump or engine is standing idle there will be no opportunity for water to collect in the vertical pipe leading to it.

A separate auxiliary steam pipe, if required, will be fitted connecting the dynamo engine with the boilers; if this separate connection is required there will be

a nonreturn stop valve on each boiler, and the pipes will lead as direct as possible to a separator placed near the dynamo engines; all dips and pockets to be carefully avoided. Valves will be fitted so that the branch leading to either boiler may be shut off when the boiler is not connected with the dynamo-engine pipe, and a valve will be fitted in the pipe leading from the separator to the engine, so that the steam may be shut off from the pipe when the engine is not in use. The trap for the separator must be of the proper size, and will be fitted with by-pass pipes and valves, so that it may be cleaned without shutting steam off from the engine. There will be an approved reducing valve in the dynamo-engine steam pipe, placed as near the boilers as possible, with a steam gauge placed where directed.

A plan of the piping and drains will be submitted to the Bureau of Steam Engineering for approval before any of the work is done upon it.

96. AUXILIARY EXHAUST PIPES.

An auxiliary exhaust pipe, of sufficient size for all auxiliary machinery herein specified, and for such other steam machinery as may be fitted in the vessel, will be fitted and connected to all auxiliary machinery. It will have valves to direct the exhaust steam into either main exhaust pipe or into either low-pressure receiver.

97. BLEEDER PIPES.

A 2-inch branch will lead from the main steam pipe in each engine room to the main exhaust pipe, with a stop valve operated from the working platform.

98. INTERMEDIATE AND LOW PRESSURE STEAM PIPES.

A branch from the main steam pipe will lead to each intermediate, and a branch to each low pressure receiver, each with a stop valve. The stop valve from the low-pressure is to be worked from the platform. The branch to the low pressure receiver will be fitted with a reducing valve of approved pattern set for a pressure of 20 pounds per square inch in the receiver.

99. MAIN FEED PIPES.

A seamless drawn-brass pipe, iron size, of the full size of the pump discharge, will lead from each main feed pump and discharge only into a pipe leading to the main check valves on both boilers so that either pump can be used on both boilers. All parts of the pipes will be above the floors, in plain view, and all joints made by flanges screwed on the pipes and bolted together.

100. AUXILIARY FEED PIPES.

A pipe similar to the main feed pipe will lead from each auxiliary feed pump to the auxiliary check valves on the boiler in the same compartment.

101. ESCAPE PIPES.

There will be a copper pipe abaft each smoke pipe, extending as high as may be designated, finished and secured in an approved manner. This pipe will have branches leading to all the safety valves in its compartment. The area will equal the combined areas of the safety valves with which it is connected.

102. DECK CONNECTIONS FROM AUXILIARY FEED PUMPS.

A 1½-inch pipe will lead from the discharge of each auxiliary feed pump to the deck with a branch to the adjoining engine room. These pipes and branches will have approved straightway valves and fire plugs where directed.

A reverse coupling will be supplied with adapters to suit the various sizes and threads of fire hose commonly in use.

103. PIPES THROUGH WATER-TIGHT BULKHEADS AND DECKS.

They will be made water-tight by stuffing boxes, flanges, or other approved means, but the bulkhead itself must form no part of the joint.

Pipes must not be led in such a manner that the angles or T's of bulkheads have to be cut.

104. DRAINPIPES AND TRAPS.

All places where condensed steam can accumulate will be provided with drainpipes and cocks or valves of ample size. The lowest part of all water pipes and all pump cylinders and channel ways will have drain cocks with pipes where required. The handles of all drain cocks will point downward when closed.

There will be an automatic trap of approved pattern for draining the radiators.

105. THICKNESS OF COPPER PIPES.

The thickness of copper straight steam piping, fire service, and blow-off pipes will be found by the following formula:

$$\frac{P \times D}{8000} + \frac{1}{16} = T. \quad \text{Where } P = \text{boiler pressure above atmosphere.}$$

D = inside diameter of pipe.

T = thickness in inches.

The thickness for feed-suction piping will be $\frac{1}{16}$ inch.

The low-pressure exhaust pipe will be No. 12, B. W. G.

All exhaust and other pipes not in the above list will be made of approved thickness. Bent copper pipes to be made from one gauge thicker material than is required for straight pipe. No bend of which the mean radius is less than one and a half times the bore of the pipe will be allowed.

106. MATERIAL AND FITTING OF PIPES.

All pipes less than 2 inches diameter, except the lower end of bilge suction pipes, will be of copper unless otherwise specified.

All steam piping above 2 inches diameter will be made of lap-welded iron, unless otherwise specified, and size and thickness must be approved by the Bureau of Steam Engineering.

The lower part of bilge-suction pipes will be of galvanized iron. All copper and brass piping of, and less than, 6 inches diameter will be seamless drawn. All copper pipes will have composition flanges brazed on and will have the end of the pipe expanded into a recess in the

face of the flange. All feed and blow pipes will have composition flanges. All flanges of copper pipes will be in accordance with the Bureau of Steam Engineering table of thickness of pipes and flanges, the flanges being made male and female where under pressure greater than 200 pounds and faced and grooved elsewhere. The joints between flanges in steam pipes will be made with approved material. No material will be used that will not withstand the heat of the steam and keep tight an indefinite length of time, and any material used must be the best that can be procured.

The Bureau of Steam Engineering must have a schedule of size, thickness, material, and construction of piping before work is commenced on it.

All composition flanges below the floor plates will be connected by bolts and nuts of rolled naval brass or Tobin bronze. All copper-pipe T pieces and fittings will be of composition, except where otherwise directed. Expansion joints of approved pattern will be fitted where required. Slip joints, if fitted, will have stop bolts and flanges. All copper pipes in bilges will be well painted, and must not rest in contact with any of the iron or steel work of the vessel.

All slip joints will consist of a composition stuffing box, follower, and entering pipe, the stuffing box and entering pipe to be connected by flanges with the pipe.

All slip joints to be packed with metallic packing, which must be approved by the Bureau of Steam Engineering.

107. AUXILIARY-ENGINE STOP VALVES.

Each auxiliary engine will have stop valves in exhaust pipes as close to cylinder as possible, and in steam pipes as before specified. Exhaust stop valves will be straight-way where practicable. All pumps, except circulating pumps, will have screw check valves in both suction and delivery pipes close to pump cylinders, so arranged that they may be kept off their seats when desired.

108. SEA VALVES.

There will be the following sea valves:

A main injection valve for each engine, fitted with a scoop;

An outboard-delivery valve for each engine, which will be fitted with a reverse scoop of the same size as that of the main injection valve to supply the condenser when the boat is running backward;

A sea valve in each fire room fitted with a scoop of sufficient size for the proper supply of auxiliary feed and fire pumps; to the chamber of this valve will be connected the pipe for wetting down ashes, and the suction pipe of evaporator pump.

There will also be fitted in each fire room a valve for bottom and surface blows, and the evaporator blow.

There will be a valve for water service pipes placed at top of inlet water chamber of each condenser.

109. BILGE STRAINERS.

The bilge connection of each auxiliary feed pump will be fitted with an approved basket or equivalent strainer above the floors.

110. ATTACHMENT OF VALVES TO HULL.

Steel strengthening rings will be riveted to plating of hull around the openings for all sea valves. The valve flanges will be bolted to these rings by rolled manganese or Tobin bronze studs, care being taken not to drill the holes entirely through the rings. A zinc protecting ring will be fitted in each opening in outer skin in such a manner as to be easily renewed.

All suction valves will have strainers over their openings on the outside of the vessel fitted as scoops in an approved manner. The details of scoops will be submitted to the Bureau of Steam Engineering before work is commenced on them. These strainers will have $\frac{3}{4}$ -inch holes with a collective area equal to twice the area of the valve openings. Strainers must be fastened to valve pipes or casings, and not to the plates of the hull.

111. COCKS AND VALVES.

All cocks and valves and their fittings, except as otherwise specified, will be of composition. All handwheels

will be of finished brass, except as otherwise specified, and will be at least one and one-half times as great in diameter as their valves. All cocks communicating with vacuum spaces will have bottoms of shell cast in and have packed plugs. All cocks over 1 inch in diameter will have packed plugs. Reducing valves will be put in where directed or required.

Valves of approved pattern will be supplied wherever necessary to complete the various pipe systems, whether herein specified or not. All valves will be so fitted as to be easily ground in, and be fitted where required with grinding-in guides and handles. No conical-faced valve will have a bearing on its seat of more than $\frac{3}{16}$ inch in width. All valve spindles must turn right-handed to close, and have outside threads where practicable. Cocks and valves may have, where approved, in lieu of wheels or permanent handles, removable box or socket wrenches, marked and stowed in convenient racks; these handles to be so fitted that they can only be removed when the valves are closed. All cocks and valves underneath the floor plates will have their wheels or handles above the floor plates, in easily accessible positions, unless otherwise directed.

The sizes of valves as given in specifications will refer to the diameter of the equivalent clear openings.

112. LABELS ON GEAR AND INSTRUMENTS.

All cocks will have engraved brass plates to show their uses and to indicate whether open or shut. All valves, except such as may be otherwise directed, will have similarly engraved plates to show their uses, or have the same plainly engraved on handwheels.

All hand levers or their quadrants will be similarly marked. Gear for working valves from deck will be marked as elsewhere specified.

All steam stop valves will have indices to show to what extent they are opened.

All gauges, thermometers, counters, telegraph dials, speaking-tube annunciators, and revolution indicators will be suitably engraved to show to what they are connected.

All engraving will be deep and be filled in with black cement.

113. CLOTHING AND LAGGING.

The main cylinders and valve chests, excepting cylinder heads, after being finally secured in place in the vessel and tested, will be covered with approved incombustible nonconducting material and neatly lagged with Russia iron all over, secured with polished brass bands and round-headed brass screws. The upper cylinder heads will be covered with sheet brass lagging $\frac{1}{32}$ inch thick, with a sheet of asbestos board beneath it.

All lagging will be so secured as to be easily removed, replaced, and repaired.

All parts of the condensers except the water chests at ends will be clothed with approved material put on in sections so as to be easily removed and replaced, and neatly lagged with Russia sheet iron secured by brass bands.

All steam and exhaust pipes and all steam valves will be clothed in an approved manner with a satisfactory nonconducting material, covered with No. 6 canvas; this canvas to be sewed on and be well painted. The main steam pipes in engine room and the separator will be also covered with approved covering. The canvas covering of steam pipes will be secured to bulkheads where the pipes pass through them.

The steam cylinders of all auxiliary engines will be clothed the same as main cylinders and will be lagged with Russia iron.

114. RADIATORS.

Radiators of approved patterns, with such areas as may be called for in the specifications for radiators to be furnished by the Bureau of Steam Engineering, will be furnished and fitted and connected.

All radiators will be fitted with approved valves, with valve-stem guards, and removable keys for valve stems. The ends of the stems will be triangular in cross sections.

The steam and drain pipes will be of seamless drawn brass, of iron-pipe size, suitably connected by composition fittings in a manner that will permit them to be easily taken down for repairs.

All union joints will be coned or have corrugated copper washers.

All holes through bulkheads will be thimble.

Steam and drain pipes will be clothed where near woodwork, and elsewhere as required.

At a point just before the steam pipes branch out forward and aft an adjustable reducing valve of approved design will be fitted. The drain pipe of all the circuits will have an approved automatic steam trap discharging into feed tank, and elsewhere as directed.

115. WHISTLE.

An approved polished brass steam whistle, with a bell of about 2 inches diameter, will be placed forward of the forward smoke pipe, well above the level of the awnings, and connected to the auxiliary steam pipe by a pipe having a stop valve at its lower end and a working valve at the upper end.

If directed a drainpipe with valve will lead to the feed tank.

116. HOSE AND ATTACHMENTS.

Fifty feet of hose will be supplied for each engine room and each fire room. The hose will be of the best quality rubber-lined linen, all $1\frac{1}{2}$ inches diameter, with couplings. Each hose will be supplied with an approved $\frac{3}{4}$ -inch nozzle. A pair of spanners will be supplied for each hose nozzle. Hose nozzles and spanners will be fitted in becketts.

117. SHAFTS THROUGH BULKHEADS.

All shafts passing through water-tight bulkheads will be fitted with stuffing boxes, each in two parts.

118. FLOORS.

The fire rooms will be floored with wrought-iron plates $\frac{1}{8}$ inch thick, with neatly matched flat-top corrugations running fore and aft. The plates will be of convenient

size and easily removable. They will rest on proper ledges of angle or T iron, and will have drain holes where necessary. In place of floors approved gratings will be used in the engine rooms.

119. LADDERS.

Ladders will be fitted wherever necessary for reaching the engine rooms and fire rooms from deck, and elsewhere if necessary.

All ladders will be so fitted as to be easily removable where required, and will be joined and hinged, with necessary fastenings and gear, where they have to be moved when closing hatches.

120. HAND RAILS.

Hand rails and all necessary dash and protection, plates, easily removable where required, will be fitted to all ladders and around moving parts of machinery, and will be secured in an approved manner. The hand rails will be made of brass tubing of diameter and thickness to be approved, and will be polished all over. The dash and protection plates will be made of steel or iron neatly finished with polished brass bands.

121. GEAR FOR WORKING VALVES FROM DECK.

The safety valves, boiler stop valves, and engine-room stop valves, will have suitable gear for working them from the main deck.

122. LIFTING GEAR.

Wherever required, holes will be tapped and eyebolts or other approved means provided for handling parts of machinery.

123. OIL TANKS.

Oil tanks of 100 gallons total capacity, will be fitted and divided as may be directed, with facilities for filling from deck. They will be made of galvanized wrought iron, and will each have a hand-hole and cover near the top, and a locked cock for drawing oil.

The tanks will be galvanized after being built.
All oil tanks will be fitted with drip pans.

124. TOOLS.

The following tools will be furnished in addition to those elsewhere specified:

One set of wrenches complete for each engine and each fire room, to be fitted for all nuts in their respective compartments, plainly marked with sizes, and fitted in iron racks of approved pattern. The wrenches for nuts of bolts less than 1 inch in diameter will be finished, and for all over 2 inches in diameter will be box wrenches, where such can be used. Socket wrenches will be furnished where required. Open-end wrenches will be of steel or wrought iron with case-hardened jaws, all others of wrought iron or cast steel.

Fixed trammels or gauges for aligning crank shafts, brass pins being let into pillow blocks and center marked for this purpose.*

Two complete sets of fire tools for each fire room.

Four coal and four ash buckets for each fire room.

All trammels and gauges will have protecting cases.

All tools will be conveniently stowed.

125. DUPLICATE PIECES.

The following duplicate pieces, in addition to others specified, will be furnished, fitted, and ready for use, viz:

One set of valves and springs for each pump;

One set of valve guards and bolts for one air pump;

One set of valve guards and bolts for one feed pump;

One set of bottom brasses for crank-shaft bearings;

One crank shaft for each engine to be fitted in place, protected in an approved manner;

One propeller for each engine, and they will be of such pattern as may be directed after the trial of the vessel;

One complete set of brasses for each main-engine valve gear, so that all the brasses can be replaced at one time;

One complete set of brasses for each circulating-pump

engine, each main feed pump, each auxiliary feed pump, and each blowing engine;

One piston rod for each size pump;

One feed-check valve complete;

One bottom-blow valve complete;

One surface-blow valve complete;

One complete set of metallic packing for each size stuffing box, in addition to four sets for piston rods;

A spare hose and nozzle for each steam tube cleaner;

One-eighth of a complete set of grate bars and bearers for all furnaces, and one pattern for each casting in furnace;

One dead plate for furnaces and one pattern for same;

One complete set of brasses for two of the main-engine connecting rods;

One complete set of brasses for two of the main engine cross heads;

Two per cent of each shape of boiler tubes used in the construction of the boilers and such other spare parts of boilers as may be required by the Bureau of Steam Engineering after an inspection of the drawings;

Two hundred condenser tubes packed in boxes;

Fifty condenser-tube glands;

One spare spring for each safety valve, one for each sentinel valve, and one for each cylinder and pump relief valve;

One spare basket for each Macomb bilge strainer;

One set of coils or tubes for each evaporator, with steam head.

Wherever duplicate pieces are furnished for one of two or more pieces of machinery of the same size, they must be made strictly interchangeable.

All finished duplicate pieces not of brass will be painted with three coats of white lead and oil and well lashed in tarred canvas, with the name painted on outside unless otherwise directed. Brass pieces will be marked or stamped. All pieces will be stowed in an approved manner.

All boiler tubes will be securely stowed in racks, or as directed.

These duplicate pieces are not to be regarded as part of the machinery weights, but are to be delivered at such navy yard as may be directed.

126. MATERIALS AND WORKMANSHIP.

All castings must be sound and true to form, and before being painted must be well cleaned of sand and scale, and all fins and roughness removed.

No imperfect casting or unsound forging will be used if the defects affect the strength or to a marked degree its sightliness.

All nuts on rough castings will fit facings raised above the surface, except where otherwise directed. All flanges of castings will be faced, and those coupled together will have their edges made fair with each other. The faces of all circular flanges will be made male and female when under pressure greater than 200 pounds to the square inch and grooved in all other places.

When required all bolt holes in permanently fixed parts will be reamed or drilled fair and true in place, and the bodies of bolts finished to fit them snugly.

All brasses will be properly channeled for the distribution of oil.

Packing for stuffing boxes will be such as may be approved.

All material used in the construction of the machinery will be of the best quality. The iron castings will be made of the best pig iron—not scrap—except where otherwise directed.

Composition castings will be made of new materials.

The various compositions will be by weight, as follows:

For all journal boxes and guide gibs where not otherwise specified: Copper 6, tin 1, and zinc $\frac{1}{4}$ parts.

Naval brass: Copper 62, tin 1, and zinc 37 per cent.

For composition not otherwise specified: Copper 88, tin 10, and zinc 2 per cent.

Manganese bronze and Muntz metal will be of the best commercial quality.

Antifriction metal will be of approved kind.

Ornamental brass fittings will be of good uniform color.

All castings will be increased in thickness around core holes. Core holes will be tapped and core plugs screwed in and locked, except where bolted covers are used, or where it may be directed that the holes be left open.

All steel forgings will be without welds and free from laminations.

All flanges, collars, and offsets will have well rounded fillets.

All boiler plates, stays, and tubes will be well cleaned of mill scale by pickling or other approved means.

All flanged parts of boilers will be annealed, after flanging, in an approved manner.

India-rubber valves will be of approved kind, of best commercial quality.

All bolts for securing the boiler attachments will, where practicable, be screwed through the boiler plates, with heads inside.

All work will be in every respect of the first quality and executed in a workmanlike and substantial manner.

Any portion of the work, whether partially or entirely completed, found defective, must be removed and satisfactorily replaced without extra charge.

127. TESTS OF MATERIAL.

All steel used in the construction of the boilers, and all steel forgings and castings, will be tested in accordance with rules to be prescribed by the Navy Department.

All boiler tubes will be tested to 1500, and condenser tubes to 300 pounds pressure per square inch, applied internally before being put in place.

If India rubber valves are used, they will be taken at random, and must stand a dry-heat test of 270° Fahrenheit for one hour, and a moist-heat test of 400° Fahrenheit for three hours, without injury.

128. TESTS OF BOILERS AND MACHINERY.

Before the boilers are painted or placed in the vessel they will be tested under a pressure of 360 pounds to the square inch above atmospheric pressure. This pressure

will be obtained by the application of heat to fresh water within the boilers, the water filling the boilers quite full.

The boilers, steam pipes, and valves and all fittings and connections subjected to the boiler pressure will be tested to 360 pounds to the square inch.

After the boilers are placed in the vessel and connections are made, the boilers and pipe connections will be tested by steam to 300 pounds per square inch, and all leaks made tight before they are clothed.

The high-pressure cylinders, jackets, and valve chests will be tested by water pressure to 360 pounds to the square inch, and the low-pressure to 90 pounds. The intermediate-pressure cylinders and connections will be tested to 180 pounds if triple expansion engines are used, and the first intermediate to 225 pounds and second intermediate to 150 pounds if quadruple expansion engines are used. The exhaust side of the low-pressure valve chest will be tested to 30 pounds. The condensers will be tested to 30 pounds.

The cylinders and condensers will be tested before being placed on board, and must be so placed that all parts may be accessible for examination by the inspector during the tests. All parts will also be tested after being secured on board. No lagging or covering is to be on the cylinders or condensers during the tests. The pumps, valve boxes, air vessels, and pipes of all feed pumps will be tested to 500 pounds per square inch. All pressures to be above atmospheric pressure.

The circulating pumps will be tested by discharging water under conditions as nearly as possible like those they will be working under when throwing water from the bilges. They must discharge the water at the same height as the water line is above the pumps and through the same length and size of pipe, drawing water from the same depth as the lowest part of the bilge-suction pipe below the pump and through the same length and size of pipe. Each pump must throw 750 gallons per minute under this head.

When the engines are completed they will be firmly bolted on a good foundation in the shop. A good dynamometer of approved design will be applied to each engine in turn. There will then be made a progressive test of each engine up to 412 revolutions at full steam pressure, beginning with low pressures of steam, and of various rates of revolution for each pressure, the engine being indicated for each speed, and the dynamometer being read at the same time.

Before this test is made the Bureau of Steam Engineering will issue explicit instructions to be followed.

129. PAINTING.

After a satisfactory test the boilers will be painted on the outside with two coats of brown zinc and oil, and when in place the fronts will be painted with one coat of black paint.

All engine work, not finished, will be primed with two coats of brown zinc and oil, and when placed in position on board the vessel will be painted with two coats of paint of approved color. The shafting, when in place, will be painted with two coats of red lead and oil and two coats of black paint.

The smoke pipes will be thoroughly painted before and after erection on board. Special care will be taken that the outside of the smoke pipe and the inside of the casing are thoroughly painted before the smoke pipe and casing are secured together. The ventilators will be painted similarly to the smoke pipes.

All pipes will be painted in accordance with a schedule to be hereafter furnished.

130. PRELIMINARY TESTS AND TRIALS.

The boilers will be used for the shop test of the engines elsewhere specified.

After boilers are placed on board and connections made, steam will not be raised to a higher pressure than 50 pounds until the specified water test has been made.

All expense of preliminary tests will be borne by the contractor.

131. SUPERINTENDING ENGINEER'S OFFICE.

A suitable office and a suitable drafting room, properly furnished and heated, will be furnished by the contractor for the use of the Superintending Naval Engineer and his assistants.

132. RECORD OF WEIGHTS.

All finished machinery, boilers, and appurtenances thereof, as fitted, and all spare machinery and tools herein specified, will be weighed by the contractor in the presence of the Superintending Naval Engineer, or one of his assistants, before being placed on board; and no part of the material will be placed on board without being so weighed to the satisfaction of the Superintending Naval Engineer.

133. WORKING DRAWINGS.

All drawings necessary for the prosecution of the work must be prepared by and at the expense of the contractor.

Those which are developments of the drawings furnished and of the specifications will be subject to the approval of the Bureau of Steam Engineering before the material is ordered or the work commenced, and a copy of each working drawing, after approval by the Bureau of Steam Engineering, will be furnished to the Superintending Naval Engineer before the work shown by the drawing is commenced. A copy of each drawing accompanying orders for steel castings or forgings will also be supplied when the work is ordered.

The drawings will be made to scale, with figured dimensions of all parts. If a correction or change is made in any part of a finished drawing, the dimension will be written with the word "marked" after it. Materials will be hatched in accordance with the Bureau standard, or be plainly marked with lettering.

In the drawings furnished, figured dimensions, where given, will be followed, and not scale dimensions, unless otherwise directed. All discrepancies discovered in drawings, in specifications, or between drawings and specifications, will be referred to the Bureau of Steam Engineering.

134. DRAWINGS OF COMPLETED MACHINERY.

The contractor will make and furnish to the Bureau of Steam Engineering, through the Superintending Naval Engineer, one complete set of drawings, and three sets of blue prints on cloth of approved quality, of the boilers, machinery, and appurtenances as actually completed, including plans of the same as fitted on board the vessel. These drawings will include every piece of machinery, both in whole and in part, and will be in such detail as would enable the entire machinery to be duplicated without additional drawings. No sheet will contain drawings of more than one part of the machinery, except those intimately connected with each other. The detail drawing of each part of the machinery will be furnished within one month after the completion of the part without waiting for its incorporation into the machine as a whole. Detail drawings will be made to a scale of not less than $1\frac{1}{2}$ inches to the foot. General plans of the machinery in place in the vessel will be made to a scale of $\frac{1}{2}$ inch to the foot.

The pipe plans will be made to a scale of not less than $\frac{3}{4}$ of an inch to the foot. The pipe plans will be divided into at least two parts—one showing steam and exhaust pipes, and the other showing all other pipes. The pipe plans will be colored in accordance with a schedule to be furnished, to indicate the purpose which the pipes are intended to serve, and accompanied by an explanatory index.

All drawings will be made on the best quality of tracing cloth; all sheets being of "double elephant" size, or multiples of this.

Detail drawings will be hatched, where in section, in accordance with a schedule to be furnished, to show the various metals employed.

135. CHANGES IN PLANS AND SPECIFICATIONS.

The contractor will make no changes in the plans or specifications without the approval of the Navy Department. In case it is thought advisable to make changes, the contractor will make application by letter to the

Bureau of Steam Engineering, through the Superintending Naval Engineer, stating the nature of the change, accompanied by complete plans and specifications of the proposed change, together with a statement of his estimate of the amount of increase or decrease in cost.

136. INSPECTION.

The work of construction of the boilers, machinery, and appurtenances shall be at all times open to inspection by officers appointed for such purpose by the Navy Department. Every facility will be afforded such inspectors for the prosecution of their work. All handling of material necessary for purposes of inspection will be done at the expense of the contractor. All test specimens necessary for the determination of the strength of material used will be prepared and tested at the expense of the contractor. The contractor will furnish the Superintending Naval Engineer with a weekly list of the number of men of each class employed upon the work, together with a statement of the number of hours' labor in each class.

137. OMISSIONS.

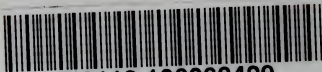
Any part of the machinery or any article pertaining thereto which may have been inadvertently omitted from the specifications or from the official drawings, but which is necessary for the proper completion of the vessel, is to be supplied by the contractor without extra charge.



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